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# A REPORT ON THE OCCURRENCE OF FERRUGINOUS BRECCIA IN CHOPAN PORCELLANITE FORMATION FROM SEMRI GROUP, SONBHADRA DISTRICT, (U.P.)

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## Abstract

The occurrence of ferruginous breccia as isolated hillocks from Kon area in the eastern part of Sonbhadra district has been reported from Chopan Porcellanite Formation of Semri Group. The breccia occupies the central top position of the hillock whereas the slope consists of tuffaceous material from Porcellanite Formation. The ferruginous breccia considerably exhibits high $Fe_2O_3$(T) 47-76.52 wt%. It is quite likely that these breccias were formed due to a short lived explosive volcanism during the deposition of the Porcellanite Formation. The field observations indicate them to be the geomorphic relicts of the suspected volcanic cone(s) of the widespread submarine felsic volcanism in the Son valley at Palaeo-Mesoproterozoic boundary.

## Introduction

Porcellanite Formation of Semri Group belonging to Vindhyan Supergroup is exposed as a linear belt along the Son River extending from Palamu district of Jharkhand towards the east and Sidhi district of Madhya Pradesh in the west. It is associated with tuffaceous shale and sandstone, pyroclastic breccia; banded cherty rock and banded porcellanite. Porcellanite Formation is attested to be of explosive origin by many earlier workers (Auden, 1933; Law, 1954; Ghosh, 1971; Srivastava, 1977; Singh and Srivastava, 1982; Soni et al. 1987; Chakrabarti et al. 2007; Mishra and Sen, 2010; Mishra et al. 2017). This Formation is referred as Chopan Porcellanite (in the eastern part) and Deonar Porcellanite (in the western part) of Vindhyan Supergroup exposed in the Son valley (Bhattacharya, 1996). The Chopan Porcellanite Formation is composed of volcaniclastic and volcano-sedimentary rocks comprising vitric and pumice tuffs, mainly ignimbrite and pyroclastic breccia. Considering pyroclastic nature of Deonar Porcellanite, they have been re-designated as Deonar Pyroclastics by Mishra et al. (2017). Mishra and Sen (2010), on the basis of geochemical data stated that pyroclastics originated as a result of violent and explosive submarine volcanism of rhyolitic nature in Chopan area. Chakrabarti et al. (2007) inferred an extinct Andean-type arc provenance towards the south on the basis of Nd-isotopic ratios. Srivastava (1977) considered them to have originated from a thick aerosol resulting from Plinian type explosive volcanic activity based on his study in Sidhi district. Soni et al. (1987) also focused on the volcanic activity in the Sidhi district in western part of the Son valley.

Srivastava et al. (2003) based on sedimentological data have identified lithofacies related to submarine and terrestrial volcanism from Chopan Porcellanite Formation in Sonbhadra district. Ghosh (1971) identified two phases of deposition of ash beds in the area WSW of Sidhi. Rasmussen et al. (2002) and Ray et al. (2002) published precise U-Pb zircon ages of 1628±8 Ma and 1631±5 Ma for Chopan Porcellanite. Bickford et al. (2017) have reported the occurrence of very coarse grained true rhyolite in the eastern part of Sonbhadra district yielding the $^{207}Pb/Pb^{206}$ age of 1642±7 Ma in the eastern most part of Sonbhadra district. Uraniferous ferruginous breccia has been reported from the western part of Deonar pyroclastics in Sidhi district by Saxena et al. (2005) and Roy et al. (2009). However, this paper is the first report of the occurrence of ferruginous breccia in the Chopan Porcellanite of Semri Group exposed in the eastern part of Vindhyan Supergroup in Sonbhadra district (Fig. 1).

## Geology of the Area

Vindhyan Basin is the largest Proterozoic basins of the world comprising thick repository (~4.5 km) of sedimentary succession dominantly of carbonate rich sediments in the lower part succeeded by siliciclastics in the upper part (Auden, 1933; Bhattacharya, 1996; Bose et al. 2001). The basin overlies the stable Bundelkhand Craton of Archean-Early Proterozoic age (Achharya, 2003; Ram Mohan et al. 2012). In Son valley area the Lower Vindhyan, also referred as Semri Group is mainly composed of volcanogenic and biochemical sediments while the overlying Upper Vindhyan consisting of Kaimur Group is dominantly a siliciclastic deposit. Patherwa Sandstone of Semri Group unconformably overlies slates and phyllites of Mahakoshal Group however the contact between Vindhayan and Mahakoshals is also a tectonic one along Son Narmada North Fault (SNNF) in this region. Kajrahat Limestone of the Semri Group is conformably overlain by the Porcellanite Formation (Table 1) which provides evidence of the large scale felsic volcanism during the Early Mesoproterozoic (Rasmussen et al. 2002; Ray et al. 2002; Bickford et al. in press). This is conformably overlain by the Kheinjua Formation which is composed of three members (Table 1) - the lowermost Olive Shale, the Fawn Limestone and the uppermost Glauconitic Sandstone. The ferruginous breccias that are being discussed here were observed in the Chopan Porcellanite Formation near Kon area of Sonbhadra district of Uttar Pradesh (Fig.1).

## Occurrence of Ferruginous Breccia in Chopan Porcellanite

Chopan Porcellanite Formation (CPF) comprises the pyroclastics of mainly tuffaceous sediments occurring both as massive and banded varieties. The black and white bands in the banded porcellanite are parallel to the general strike of Vindhyan Supergroup. The banded variety of porcellanite constitutes 80% of total porcellanite exposure in Son valley. The massive tuffaceous sediments occur in variegated colours ranging from opaline green, grey, buff, olive green bluish grey and black. In the area under investigation around Kon (Fig. 1) massive black and buff varieties of porcellanite of tuffaceous nature are exposed. The compact massive black porcellanite is thickly

bedded and quartz phenocrysts and calcite filled vesicles can be observed with naked eyes. The buff coloured porcellanite is thinly bedded. Thin section study indicates that the black and buff coloured massive porcellanite are welded ignimbrite displaying varieties of texture like spherulitic, porphyitic etc.

Remarkable but localized occurrence of ferruginous breccia was observed within the Chopan Porcellanite Formation near Kon area (Fig. 1, 2, 3, 4). Ample evidences are present in this area that the iron was being extracted by the local people in the past from these ferruginous breccias which are at Khempur and Karaundiya villages of Sonbhadra district near Jharkhand (Fig. 1). Ferruginous breccia is exposed at the top of the isolated and small hillocks in these villages whereas their slopes consist of the tuffaceous material of Porcellanite Formation (Fig. 2). The coarse grained true rhyolitic flow is exposed in the nearby area reported by Bickford et al. (2017). Ferruginous breccia is traversed by quartz veins and displays boxwork structure (Fig. 3). Breccia and other cataclastites are often considered evidence of faulting in the region. In these cases the breccias are generally localized along the fault planes and the brecciation affects all the intervening strata through which the fault plane passes. But as discussed earlier the ferruginous breccias in the study area occur over unaffected fine grained tuffaceous material of the Porcellanite Formation. Though they are seen in localized areas over the hillocks, their occurrence is more indicative of depositional process rather than fault generated. The brecciation process however, requires tremendous energy to generate the big angular chunks of rock fragments. It seems more likely that these breccias are formed due to a short lived explosive volcanism during the deposition of the Porcellanite Formation. Keeping in mind the bigger size of the chunks compared to those of the other overlying and underlying rocks, the source and site of this short lived explosion must be in close vicinity to the present depositional site of these ferruginous breccias. It appears that the explosive volcanism was submarine and site of which was later concealed under the overlying sediment deposits. As such there is no rock in the Lower Vindhyan sequence which could supply iron for these ferruginous breccias, therefore it also appear that the source of explosion was deep enough in the Mahakoshal Group rocks which contain a Banded Iron Formation horizon. The field evidences (Fig. 2, 3, 4a, 4b) supported by geochemical analysis (Fig. 5; Table 2)) indicate presence of haematite in these breccias (Fig. 4a). The iron was remobilized and deposited along their cracks. Later on the tuffaceous material or fine grained porcellanite present in the angular cavities of the breccia underwent weathering and got converted to clayey material (Fig. 4b). The clayey material was gradually removed from the cavities of ferruginous breccia to form box work structure (Fig. 3).

The XRD data of clay separated ferruginous material of breccia indicates presence of minerals like illite, gonyerite (variety of chlorite), montmorillite and hematite (Fig. 5).

The major oxides of five samples of ferruginous breccia were analysed using Philips X'unique II–WDXRFS (Wavelength Dispersive X-Ray Fluorescence Spectroscopy) at Geochemical Laboratory, Atomic Mineral Division, Hyderabad. The

details of sample preparation for analysis by WDXRF are dealt in Vishwanathan (1989). Overall precision and accuracy, as determined by replicate analyses, are estimated 2–5% (RSD) for major elements with >0.5%. The major oxide data of 2 samples are from Karaundiya village 3 samples are from Khempur village are presented in Table 2. $Fe_2O_3$(T) is considerably higher in ferruginous breccia in Karaundiya village (47-76.52%) as compared to Khempur village (25-40%). MnO is showing considerable enrichment in the samples (0.1-1.3%). KH-1 and KH-2 samples have high alumina compared to other samples from Karaundiya village indicating the presence clayey material.

**Discussion and Conclusion**

The tuffacous ash beds belonging to Porcellanite Formation around Kon area show the occurrence of ferruginous breccia in the form of small hillocks of mappable dimension. Earlier workers have documented Plinian type of explosive volcanic activity for the deposition of Porcellanite Formation (Ghosh, 1971; Srivastava 1977; Soni et al. 1987). We have discussed that the ferruginous breccia exposed on the top of hillock whereas on slopes fine grained tuffaceous material is present. The field observations indicate these hills to be the geomorphic relicts of the suspected volcanic cone(s) and volcanic centres of the widespread submarine felsic volcanism in the Son valley at Palaeo-Mesoproterozoic boundary. The coarse grained rhyolitic flow has been reported (Bickford et al. 2017) from the same vicinity. The ferruginous breccia has been reported from the western part of Deonar pyroclastics in Sidhi district exhibits uranium mineralization (Saxena et al. 2005; Roy et al. 2009). Further the ferruginous breccia exposed in the eastern part of Son valley in Sonbhadra district needs to be investigated for uranium mineralization.

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**Tables and Figures**

**Table 1 :** Generalised Vindhyan stratigraphy in the Son valley (after Prakash and Dalela, 1982).

| Group | Formation | Member |
|---|---|---|
| | **Kaimur Group (Upper Vindhyan)** | |
| ----------unconformity | | ---------- |
| | **Rohtas** | Scarp Limestone<br>Black Shale<br>Ghaghar Limestone |
| | **Kheinjua** | Glauconitic Sandstone (80-150m)<br>Fawn Limestone (20-25m)<br>Olive Shale (350-600m) |
| **Semri Son valley Group (Lower Vindhyan)** | **Porcellanite** | Banded green porcellanite<br>Banded porcellanite<br>Tuff and pebble beds |
| | **Kajarhat** | Kajarhat Limestone |
| | **Basal Conglomerate** | Arangi shale<br>Patherwa Sandstone |
| ~~~~~~~~~~~~~~~~~~unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ | | |
| | **Mahakoshal Group** | |

**Table 2 :** Major oxide (wt%) of ferruginous breccia at Karaundiya and Khempur villages, Sonbhadra district, U.P.

| Sample | KAR-1 | KAR-2 | KAR-7 | KH-1 | KH-2 |
|---|---|---|---|---|---|
| Lat. | N24°25'34" | N24°25'46" | N24°25'31.5" | N24°26'12.6" | N24°26'22.7" |
| Long. | E83°22'43" | E83°22'40" | E83°22'25.6" | E83°19'13.8" | E83°19'20.9" |
| $SiO_2$ | 34.5 | 18.3 | 46.36 | 54.7 | 42 |
| $TiO_2$ | 0.1 | 0.1 | 0.1 | 0.7 | 0.5 |
| $Al_2O_3$ | 1.9 | 2.1 | 3 | 13.4 | 10.3 |
| $Fe_2O_3$ | 60.34 | 76.52 | 47.1 | 25.21 | 40.02 |
| MgO | 0.01 | 0.1 | 0.2 | 1.4 | 1 |
| MnO | 0.1 | 0.4 | 0.5 | 0.2 | 1.3 |
| CaO | 0.71 | 0.34 | 0.28 | 0.27 | 0.27 |
| $Na_2O$ | 0.02 | 0.02 | 0.02 | 0.1 | 0.02 |
| $K_2O$ | 0.2 | 0.6 | 0.7 | 3.6 | 3.1 |
| $P_2O_5$ | 0.36 | 0.16 | 0.14 | 0.11 | 0.13 |
| Total | 98.24 | 98.64 | 98.4 | 99.69 | 98.64 |

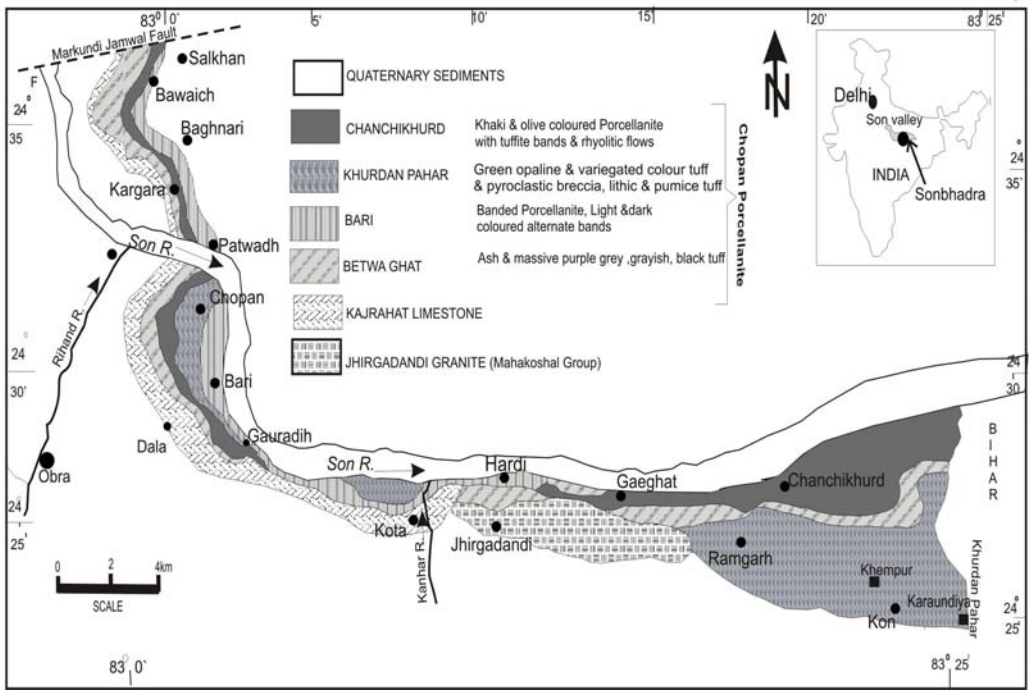


**Fig. 1:** Geological map of Chopan Porcellanite Shale along Son valley (adapted from Srivastava et al., 2003). Filled squares are sample locations at Karaundiya and Khempur village near Kon in eastern most part of Sonbhadra district of Uttar Pradesh.


**Fig. 2:** Field photograph showing central portion of hillock consisting of ferruginous breccia whereas slope comprise tuffaceous material of Porcellanite Formation.


**Fig. 3:** Box work structure in ferruginous breccia.

**Fig. 4a:** Brecciated porcellanite shale. Notice angular fragments of tuffaceous material.

**Fig. 4b:** The cavity of the box work structure initially occupied by tuffaceous material of porcellanite converted to clay.

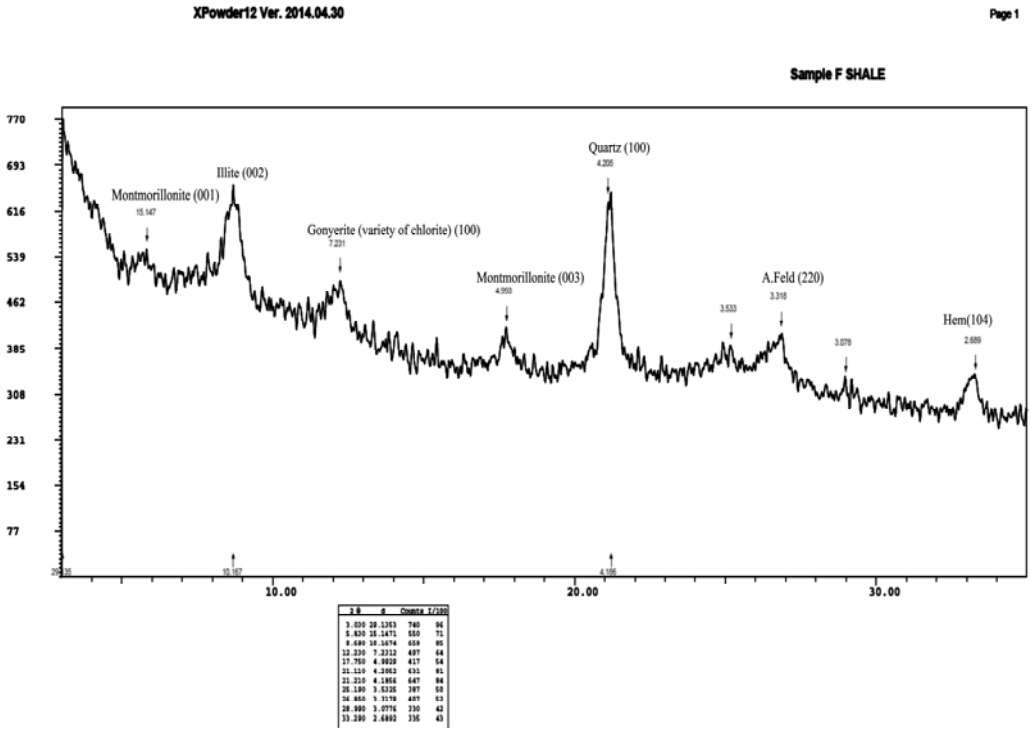


**Fig. 5:** X-Ray diffractogram of clay separated from ferruginous material of breccia.